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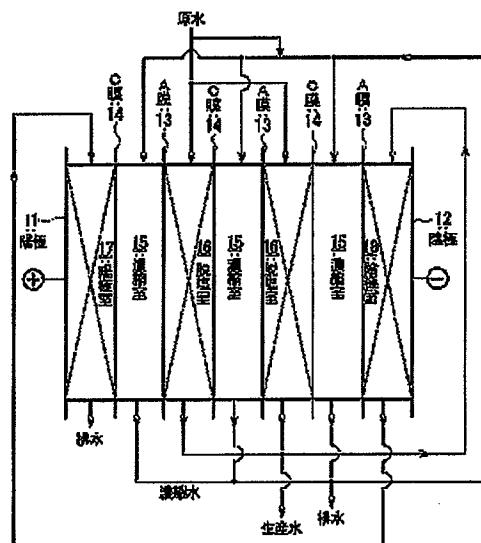
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(54)【発明の名称】 電気脱イオン装置

(57)【要約】

【課題】 電気脱イオン装置の電極室に充填したイオン導電性物質の性能低下を防止して長期運転を可能とする。

【解決手段】 陽極11を有する陽極室17と、陰極12を有する陰極室18と、これらの陽極室17と陰極室18との間に複数のアニオングループ膜13及びカチオングループ膜14を交互に配列することにより交互に形成された濃縮室15及び脱水室16とを備える電気脱イオン装置。陽極室17及び陰極室18にイオン導電性物質が充填されており、陽極室17にはアニオンを除去した水又は純水が通水され、陰極室18にはカチオンを除去した水又は純水が通水される。



【特許請求の範囲】

【請求項1】陽極を有する陽極室と、陰極を有する陰極室と、これらの陽極室と陰極室との間に複数のアニオン交換膜及びカチオン交換膜を交互に配列することにより交互に形成された濃縮室及び脱塩室とを備え。

陽極室にはカチオン交換膜を介して濃縮室が隣接し、陰極室にはアニオン交換膜を介して濃縮室が隣接している電気脱イオン装置において。

陽極室及び陰極室にイオン導電性物質が充填されており。

陽極室にはアニオンを除去した水又は純水が通水され、陰極室にはカチオンを除去した水又は純水が通水されることを特徴とする電気脱イオン装置。

【請求項2】請求項1において、陽極室のイオン導電性物質がイオン交換樹脂及び／又は活性炭であり、陰極室のイオン導電性物質がイオン交換樹脂であることを特徴とする電気脱イオン装置。

【請求項3】請求項2において、イオン導電性物質に重金属が担持されていることを特徴とする電気脱イオン装置。

【請求項4】請求項1ないし3のいずれか1項において、陰極室流出水を陽極室流入水とすることを特徴とする電気脱イオン装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は電気脱イオン装置に係り、特に電気脱イオン装置の陽極室（陽極室及び陰極室）にイオン導電性物質を充填することにより電気効率を高めた電気脱イオン装置において、電極室に充填したイオン導電性物質の性能低下を防止して長期運転を可能とした電気脱イオン装置に関する。

【0002】

【従来の技術】従来、半導体製造工場、液晶製造工場、製薬工業、食品工業、電力工業等の各種の産業又は民生用ないし研究施設等において使用される脱イオン水の製造には、図2に示す如く、電極（陽極11、陰極12）の間に複数のアニオン交換膜（A膜）13及びカチオン交換膜（C膜）14を交互に配列して濃縮室15と脱塩室16とを交互に形成し、脱塩室16にイオン交換樹脂、イオン交換樹脂もしくはグラフト交換体等からなるアニオン交換体及びカチオン交換体を混合もしくは複層状に充填した電気脱イオン装置が多用されている（特許第1782943号、特許第2751090号、特許第2699256号）。なお、図2において、17は陽極室、18は陰極室であり、一般にスペーサが設けられている。

【0003】脱塩室16に流入したイオンはその親和力、濃度及び移動度に基いてイオン交換体と反応し、荷位の傾きの方向にイオン交換体中を移動し、更に膜を構切って移動し、すべての室において電荷の中和が保たれ

る。そして、膜のイオン選択性透過特性のため、及び荷位の傾きの方向性のために、イオンは脱塩室16では減少し、隣りの濃縮室15では濃縮される。即ち、カチオンはカチオン交換膜14を通過して、また、アニオンはアニオン交換膜13を通過して、それぞれ濃縮室15内に濃縮される。このため、脱塩室16から生産水として脱イオン水（純水）が回収される。

【0004】原水は脱塩室16と濃縮室15とに導入され、脱塩室16からは脱イオン水（純水）が取り出される。一方、濃縮室15から流出するイオンが濃縮された濃縮水は、ポンプ（図示せず）により一部が水回収率の向上のために濃縮室15の入口側に循環され、残部が系内のイオンの濃縮を防止するために排水として系外へ排出される。

【0005】なお、陽極室17及び陰極室18にも電極水が通路されており、この電極水には、導電性の確保のために数十μS/cm以上の電気伝導率を有する導電性のある水を供給するか、或いはNaCl等の電解質が添加される。

【0006】特開平10-43554号公報には陰極室に電気伝導粒子を充填することが提案されており、また、USP5,868,915には、電極室にイオン導電性物質を充填することが提案されており、このように電極室にイオン導電性物質を充填した場合には、このイオン導電性物質により、電極室の導電性を確保することができるため、電極水への電解質の添加や導電性の水の補給を不要とすることができる。

【0007】

【発明が解決しようとする課題】電極室にイオン導電性物質を充填した電気脱イオン装置は、電極室の電気抵抗が小さく、電気効率が高いという利点を有するが、陽極室では発生する塩素等の酸化剤によるイオン導電性物質の劣化の問題があり、また、陰極室ではスケール析出によるイオン導電性物質の性能低下の問題があり、長期運転を継続することができないという問題があった。

【0008】本発明は上記従来の問題点を解決し、電極室に充填したイオン導電性物質の性能低下を防止して長期運転を可能とした電気脱イオン装置を提供することを目的とする。

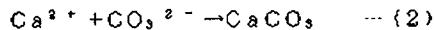
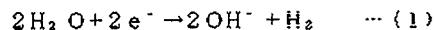
【0009】

【課題を解決するための手段】本発明の電気脱イオン装置は、陽極を有する陽極室と、陰極を有する陰極室と、これらの陽極室と陰極室との間に複数のアニオン交換膜及びカチオン交換膜を交互に配列することにより交互に形成された濃縮室及び脱塩室とを備え、陽極室にはカチオン交換膜を介して濃縮室が隣接し、陰極室にはアニオン交換膜を介して濃縮室が隣接している電気脱イオン装置において、陽極室及び陰極室にイオン導電性物質が充填されており、陽極室にはアニオンを除去した水又は純水が通水され、陰極室にはカチオンを除去した水又は純

水が通水されることを特徴とする。

【0010】本発明の電気脱イオン装置は、陰極室にイオン導電性物質を充填したため、陰極室の電気抵抗が小さく、電気効率が高い。

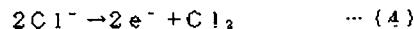
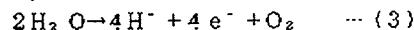
【0011】電気脱イオン装置の陰極室においては、以下の(1)の反応でOH⁻が発生する。そして、カチオンを含有する電解水をイオン導電性物質が充填された陰極室に通水すると、陰極室においては、下記(2)の反応でカルシウムスケールが生成し、このカルシウムスケールの生成反応がOH⁻により促進される。



【0012】このため、Ca²⁺イオンを含む水をイオン導電性物質が充填された陰極室に通水すると、陰極室で発生するスケールのためにイオン導電性物質の性能低下が生じる。

【0013】本発明では、Ca²⁺イオン等のカチオンを除去した水又は純水を陰極室に通水するため、このようなスケールの生成が防止され、イオン導電性物質の性能低下を生じることがない。

【0014】また、陽極室においては、以下の(3)、(4)の反応が起こり、塩素が生成し、生成した塩素によりイオン交換樹脂等のイオン導電性物質が酸化劣化する。



【0015】本発明では、Cl⁻イオン等のアノンを除去した水又は純水を陽極室に通水するため、塩素の生成が防止され、イオン導電性物質の酸化劣化が防止される。

【0016】陰極室及び陽極室に充填するイオン導電性物質としてはイオン交換樹脂が挙げられるが、陽極室においては、塩素以外にも酸化力の強いオゾン(O₃)が発生するため、還元作用のある活性炭を用いることが効果的であり、活性炭を単独で用いるか或いは活性炭とイオン交換樹脂とを混合して用いても良い。

【0017】また、イオン導電性物質として、重金属を担持したものを用いることにより、重金属が導電性を増加させるという作用により、更に電気抵抗を低減させるという効果を得ることができ、好ましい。

【0018】また、陰極室の流出水には、前記(1)の反応で発生した水素が含まれている。この還元性の水素を含む陰極室流出水を陽極室の流入水とすることにより、陽極室で発生する酸化性物質を還元して除去することができ、陽極室におけるイオン導電性物質の酸化劣化をより確実に防止することができる。この陰極室流出水は、陰極室からアノン交換膜を透過してCl⁻等のアノン成分が除去されているため、陽極室に通水するアノン成分除去水として有効に利用することができる。

【0019】

【発明の実施の形態】以下に図面を参照して本発明の実施の形態を詳細に説明する。

【0020】図1は本発明の実施の形態を示す電気脱イオン装置の模式的な断面図である。

【0021】この電気脱イオン装置は、図2に示す従来の電気脱イオン装置と同様、陽極11、陰極12の間に複数のアノン交換膜(A膜)13及びカチオン交換膜(C膜)14を交互に配列して濃縮室15と脱塩室16とを交互に形成したものであり、脱塩室16には、イオン交換樹脂、イオン交換樹脂もしくはグラフト交換体等からなるアノン交換体及びカチオン交換体が混合もしくは複数状に充填されている。

【0022】陽極室17及び陰極室18は各々カチオン交換膜14及びアノン交換膜13を介して濃縮室15と隣接しており、この陽極室17及び陰極室18にはイオン導電性物質が充填されている。

【0023】原水は脱塩室16と濃縮室15に導入され、脱塩室16からは生産水(純水)が取り出される。この生産水の一部は、陰極室18流入水として陰極室18の入口側へ送給される。陰極室18の流出水は陽極室17の入口側へ送給され、陽極室17の流出水は排水として系外へ排出される。濃縮室15から流出するイオンが濃縮された濃縮水は、一部が濃縮室15の入口側に循環され、残部は排水として系外へ排出される。

【0024】この電気脱イオン装置では、陽極室17及び陰極室18にイオン導電性物質が充填されているため、電極室の電気抵抗が小さく、電気効率が高い。

【0025】このイオン導電性物質としては、イオン交換樹脂、イオン交換樹脂、グラフト交換体等のイオン交換体が挙げられるが、陰極室18のイオン導電性物質としては、アノン交換樹脂とカチオン交換樹脂との混床イオン交換樹脂等の混合イオン交換体、或いはカチオン交換樹脂等のカチオン交換体単独、或いは活性炭、或いは活性炭とこれらのイオン交換体との混合物を用いるのが好ましい。

【0026】一方、陽極室17のイオン導電性物質としては、アノン交換樹脂とカチオン交換樹脂との混床イオン交換樹脂等の混合イオン交換体、或いはカチオン交換樹脂等のカチオン交換体単独、或いは活性炭、或いは活性炭とこれらのイオン交換体との混合物を用いることができる。

【0027】陽極室17に活性炭を充填することは、前述の如く、活性炭の還元作用で陽極室17における酸化劣化を防止することができ、好ましい。

【0028】また、陰極室18及び陽極室17に充填するイオン交換樹脂等のイオン交換体の一部又は全部にパラジウム、鉄、マンガン等の重金属の1種又は2種以上を担持させても良く、このような重金属を担持させることにより、更に電気抵抗を低減させるという効果が奏される。この場合、重金属の担持量には特に制限はないが、イオン交換体に対して0.5~10重量%程度とす

るのが好ましい。

【0029】また、イオン交換体と共に活性炭を併用したり、イオン交換体に重金属を担持させる場合、活性炭や重金属担持イオン交換体を陰極室内の陰極板面に沿って充填し、優先的に反応させることも効果的である。

【0030】図1の電気脱イオン装置では、このようにイオン導電性物質を充填した陰極室18に生産水(純水)を通水するため、陰極室18におけるスケール発生が防止され、スケールによるイオン導電性物質の性能低下が防止される。

【0031】また、陽極室17に通水される陰極室18の流出水は、純水が陽極室17に通水されたものであり、アニオン成分を含まず。しかも、陰極室18内での電極反応で生成した還元性物質の水素を含むため、陽極室17におけるイオン導電性物質の酸化劣化が防止される。

【0032】なお、図1に示す電気脱イオン装置は本発明の電気脱イオン装置の実施の形態の一例であって、本発明はその要旨を超えない限り、何ら図示のものに限定されるものではない。

【0033】例えば、図1の電気脱イオン装置では濃縮室15はイオン導電性物質が充填されていないが、この濃縮室にもイオン交換体、活性炭又は金属等のイオン導電性物質が充填されていても良い。また、図1の電気脱イオン装置では生産水を陰極室18の流入水としているが、陰極室18の流入水としては、別系統の純水或いは原水をカチオン交換樹脂塔で処理したカチオン成分除去*

*水(軟水)を用いても良い。また、陽極室17の流入水についても、陰極室18の流出水を用いる他、生産水や別系統の純水或いは原水をアノイオン交換樹脂塔で処理したアノイオン成分除去水を用いても良い。更に、過塩素水についても必ずしも一部を循環する必要はなく、水回収率よりも生産水の水質が重視される場合には、原水を一過性で通水しても良く、その通水方向等も任意である。

【0034】

【発明の効果】以上詳述した通り、本発明によれば、電極室にイオン導電性物質を充填して電気効率を高めた電気脱イオン装置において、電極室に充填したイオン導電性物質の性能低下を防止することができ、これにより長期連続運転が可能な電気脱イオン装置が提供される。

【図面の簡単な説明】

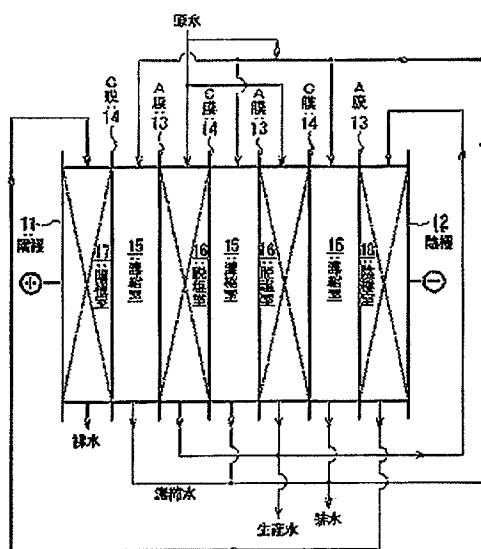
【図1】本発明の実施の形態を示す電気脱イオン装置の模式的な断面図である。

【図2】従来の電気脱イオン装置を示す模式的な断面図である。

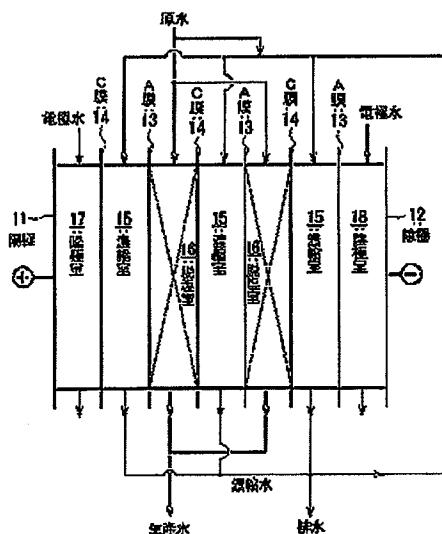
【符号の説明】

- 20 11 阳極
- 12 陰極
- 13 アニオニン交換膜(A膜)
- 14 カチオニン交換膜(C膜)
- 15 濃縮室
- 16 脱塩室
- 17 阳極室
- 18 陰極室

【図1】



【図2】



フロントページの焼き

F ターム(参考) 4D006 GA17 JA30C KA31 KD19
MA13 MA14 PA01 PB02
4D061 DA01 DB18 EA09 EB13 FA08
FA17

(19) JAPANESE PATENT OFFICE (JP)
(12) Official Gazette for Unexamined Patent
Publications (A)

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(P2003-94064A)

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 B01D 61/48 C02F 1/46 103 4D061
Request for Substantive Examination: Not yet submitted
15 Number of claims: 4 OL
(Total of 5 pages [in the Japanese text])

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(54) [Title of the Invention] Electric deionizer

(57) [Abstract]

[Issue] To prevent a reduction in performance of an ion
5 conductive substance which fills the electrode chambers
of an electric deionizer, thereby enabling long-term
operation.

[Means of Resolution] An electric deionizer comprising:
10 an anode chamber 17 having an anode 11; a cathode
chamber 18 having a cathode 12; and enriching chambers
15 and desalination chambers 16 which are alternately
formed by a plurality of anion exchange membranes 13
and cation exchange membranes 14 which are alternately
15 arranged between the anode chamber 17 and cathode
chamber 18. The anode chamber 17 and cathode chamber 18
are filled with an ion conductive substance, and de-
anionized water or pure water passes through the anode
chamber 17, while de-cationized water or pure water
20 passes through the cathode chamber 18.

raw water

11: anode

12: cathode

25 13: A membrane

14: C membrane

15: enrichment chamber

16: desalination chamber

17: anode chamber

30 18: cathode chamber

waste water

enriched water

waste water

production water

[Scope of the Patent Claims]

- [Claim 1] An electric deionizer comprising: an anode chamber having an anode; a cathode chamber having a cathode; and enriching chambers and desalination chambers which are alternately formed by a plurality of anion exchange membranes and cation exchange membranes which are alternately arranged between the anode chamber and cathode chamber; and
- 5 an enrichment chamber lies adjacent to the anode chamber with a cation exchange membrane interposed, and an enrichment chamber lies adjacent to the cathode chamber with an anion exchange membrane interposed, wherein the anode chamber and the cathode chamber are filled with an ion conductive substance;
- 10 de-anionized water or pure water passes through the anode chamber; and
- de-cationized water or pure water passes through the cathode chamber.
- 15 [Claim 2] The electric deionizer as claimed in claim 1, wherein the ion conductive substance in the anode chamber is an ion exchange resin and/or activated carbon, and the ion conductive substance in the cathode chamber is an ion exchange resin.
- 20 [Claim 3] The electric deionizer as claimed in claim 2, wherein a heavy metal is supported by the ion conductive substance.
- 25 [Claim 4] The electric deionizer as claimed in any one of claims 1 to 3, wherein the cathode chamber outflow water is used as the anode chamber inflow water.

[Detailed Description of the Invention]

- 30 [0001]
- [Technical Field of the Invention] The present invention relates to an electric deionizer, and in particular the invention relates to an electric deionizer in which the electrical efficiency is

improved by filling the electrode chambers (anode chamber and cathode chamber) thereof with an ion conductive substance, and a reduction in the performance of the ion conductive substance which fills
5 the electrode chambers of the electric deionizer is prevented, thereby enabling long-term operation.

[0002]

[Prior Art] Electric deionizers such as that shown in
10 Figure 2, in which enrichment chambers 15 and desalination chambers 16 are alternately formed by a plurality of anion exchange membranes (A membranes) 13 and cation exchange membranes (C membranes) 14 which are alternately arranged between electrodes (anode 11,
15 cathode 12), and in which the desalination chambers 16 are filled with a mixture or stacked layers of anion exchange material or cation exchange material comprising ion exchange resins, ion exchange fibers or graft exchange material etc., are widely used in the
20 production of deionized water for use in various industrial and commercial fields and research facilities, including semiconductor production plants, liquid crystal production plants, the pharmaceutical industry, the food industry, and the power industry,
25 among others (Japanese Patents 1782943, 2751090, 2699256). In Figure 2, 17 is an anode chamber and 18 is a cathode chamber, and spacers are generally provided.

[0003] Ions which flow into the desalination chambers
30 16 react with the ion exchange material due to the affinity, concentration and mobility of these ions, which then move through the ion exchange material in the direction of the potential gradient, and move across the membrane, and a neutral charge is maintained
35 in all of the chambers. The ions are decreased in the desalination chambers 16 and are enriched in the adjacent enrichment chambers 15 because of the characteristics of the membranes which are selectively permeable to ions, and because of the directivity of

the potential gradient. That is to say, cations pass through the cation exchange membranes 14, and anions pass through the anion exchange membranes 13 so as to be concentrated in the enrichment chambers 15.

5 Consequently, deionized water (pure water) is recovered from the desalination chambers 16 as production water.

[0004] Raw water is introduced into the desalination chambers 16 and enrichment chambers 15 and deionized
10 water (pure water) is recovered from the desalination chambers 16. Meanwhile, some of the enriched water which has been enriched with the ions flowing out from the enrichment chambers 15 is circulated to the inlet side of the enrichment chambers 15 by means of a pump
15 (not depicted) in order to raise the water recovery rate, and the remainder is discharged to outside the system as waste water in order to prevent ion enrichment inside the system.

20 [0005] Moreover, electrode water is also allowed to pass through the anode chamber 17 and cathode chamber 18, and this electrode water is replenished with conductive water having electrical conductivity of several tens of $\mu\text{S}/\text{cm}$ or greater, or an NaCl
25 electrolyte or similar is added thereto in order to ensure conductivity.

[0006] Japanese Unexamined Patent Application Publication H10-43554 proposes filling the cathode
30 chamber with conductive particles, and USP 5,868,915 proposes filling the electrode chambers with an ion conductive substance; when the electrode chambers are filled with an ion conductive substance in this way, the ion conductive substance makes it possible to
35 ensure conductivity in the electrode chambers, and therefore it is no longer necessary to add the electrolyte to the electrode water or to replenish same with conductive water.

[0007]

[Issues to be Resolved by the Invention] With electric deionizers in which the electrode chambers are filled with an ion conductive substance, there are advantages
5 in that the electrical resistance is low and the electrical efficiency is high in the electrode chambers, but there are problems in that the ion conductive substance deteriorates because of oxidizing agents such as chlorine which are generated in the anode chamber;
10 there are further problems in that there is a reduction in performance of the ion conductive substance because of scale deposition in the cathode chamber, and also in that operation cannot be continued over prolonged periods of time.

15

[0008] The present invention aims to resolve these problems by providing an electric deionizer in which reductions in performance of the ion conductive substance which fills the electrode chambers are prevented, thereby enabling long-term operation.

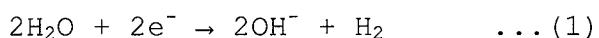
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[0009]

[Means of Resolving the Issues] The electric deionizer according to the present invention comprises: an anode chamber having an anode; a cathode chamber having a cathode; and enriching chambers and desalination chambers which are alternately formed by a plurality of anion exchange membranes and cation exchange membranes which are alternately arranged between the anode chamber and cathode chamber; and an enrichment chamber lies adjacent to the anode chamber with a cation exchange membrane interposed, and an enrichment chamber lies adjacent to the cathode chamber with an anion exchange membrane interposed, wherein the anode chamber and the cathode chamber are filled with an ion conductive substance; de-anionized water or pure water passes through the anode chamber; and de-cationized water or pure water passes through the cathode chamber.

[0010] The electrode chambers of the electric deionizer according to the present invention are filled with an ion conductive substance, and therefore the electrical resistance is low and the electrical efficiency is high
5 in the electrode chambers.

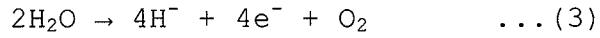
[0011] In the cathode chamber of the electric deionizer, OH⁻ is generated by the reaction in (1) below. Then, when the electrode water which contains cations passes
10 through the cathode chamber which is filled with the ion conductive substance, calcium scale is generated in the cathode chamber by the reaction in (2) below, and the calcium scale generating reaction is promoted by OH⁻.
15



[0012] Consequently, when water containing Ca²⁺ ions passes through the cathode chamber which is filled with the ion conductive substance, there is a reduction in the performance of the ion conductive substance because of the scale which is generated in the cathode chamber.
20

[0013] In the present invention, de-cationized water, from which Ca²⁺ ions or the like have been removed, or pure water passes through the cathode chamber, and therefore scale is prevented from being generated and there is no reduction in performance of the ion
30 conductive substance.

[0014] Furthermore, the following reactions in (3) and (4) take place in the anode chamber, where chlorine is generated and the ion conductive substance such as an
35 ion exchange resin undergoes oxidative degradation caused by the generation of chlorine.



[0015] In the present invention, de-anionized water, from which Cl^- ions or the like have been removed, or pure water passes through the anode chamber, and 5 therefore chlorine generation is prevented and oxidative degradation of the ion conductive substance is prevented.

[0016] Ion exchange resin may be cited as an ion 10 conductive substance for filling the cathode chamber and the anode chamber, but ozone (O_3) which has a strong oxidizing power is also generated besides chlorine in the anode chamber, and therefore it is effective to use activated carbon which has a reducing 15 action; the activated carbon may be used alone or ion exchange resin and activated carbon may be mixed together for use.

[0017] Furthermore, if a substance which supports a 20 heavy metal is used as the ion conductive substance, it is possible to achieve an effect whereby the electrical resistance is further reduced because the heavy metal acts to increase conductivity, and this is preferred.

25 [0018] Furthermore, the cathode chamber outflow water contains hydrogen which is generated in the reaction (1) above. The cathode chamber outflow water containing this reducing hydrogen serves as the anode chamber inflow water, and this means that it is possible to 30 reduce and remove the oxidizing substances generated in the anode chamber, and it is possible to more reliably prevent oxidative degradation of the ion conductive substance in the anode chamber. The cathode outflow water exits the cathode chamber and passes through the 35 anion exchange membranes whereby the anion component such as Cl^- is removed therefrom, which means that this water can be effectively utilized as water from which the anion component has been removed that passes through the anode chamber.

[0019]

[Mode of Embodiment of the Invention] A mode of embodiment of the present invention will be described 5 below in detail with reference to the figures.

[0020] Figure 1 is a schematic view in cross section of the electric deionizer which represents a mode of embodiment of the present invention.

10

[0021] Like the conventional electric deionizer shown in Figure 2, this electric deionizer is a device in which enrichment chambers 15 and desalination chambers 16 are alternately formed by a plurality of anion exchange membranes (A membranes) 13 and cation exchange membranes (C membranes) 14 which are alternately arranged between electrodes (anode 11, cathode 12), and in which the desalination chambers 16 are filled with a mixture or stacked layers of anion exchange material or 20 cation exchange material comprising ion exchange resins, ion exchange fibers or graft exchange material etc.

[0022] The anode chamber 17 and cathode chamber 18 are both adjacent to enrichment chambers 15, with a cation exchange membrane 14 and an anion exchange membrane 13 interposed, respectively, and the anode chamber 17 and cathode chamber 18 are filled with an ion conductive substance.

30 [0023] Raw water is introduced into the desalination chambers 16 and enrichment chambers 15 and production water (pure water) is recovered from the desalination chambers 16. Some of the production water is pumped to the inlet side of the cathode chamber 18 as cathode 35 chamber 18 inflow water. The cathode chamber 18 outflow water is pumped to the inlet side of the anode chamber 17, and the anode chamber 17 outflow water is discharged to outside the system as waste water. Some of the enriched water which has been enriched with the

ions flowing out from the enrichment chambers 15 is circulated to the inlet side of the enrichment chambers 15, and the remainder is discharged to outside the system as waste water.

5

[0024] With this electric deionizer, the anode chamber 17 and cathode chamber 18 are filled with the ion conductive substance, and therefore the electrical resistance is low and the electrical efficiency is high
10 in the electrode chambers.

[0025] Ion exchange material such as ion exchange resin, ion exchange fibers or graft exchange material may be cited as ion conductive substances; the ion conductive substance used in the cathode chamber 18 is preferably a mixed ion exchange material such as a mixed bed ion exchange resin comprising anion exchange resin and cation exchange resin, or an anion exchange material alone such as anion exchange resin.
15

20

[0026] On the other hand, the ion conductive substance used in the anode chamber 17 is preferably a mixed ion exchange material such as a mixed bed ion exchange resin comprising anion exchange resin and cation exchange resin, or a cation exchange material alone such as cation exchange resin, or a mixture of activated carbon and these ion exchange materials.
25

[0027] Filling the anode chamber 17 with activated carbon makes it possible to prevent oxidative degradation in the anode chamber 17, by virtue of the reducing action of the activated carbon, as was described above, and this is preferable.
30

[0028] Furthermore, one or two or more types of heavy metals such as palladium, iron and manganese may be supported by some or all of the ion exchange materials such as the ion exchange resins which fill the cathode chamber 18 and anode chamber 17; when such heavy metals
35

are supported, an effect is demonstrated whereby the electrical resistance is further reduced. In this case, no particular limitation is imposed on the amount of heavy metal supported, but this amount is preferably
5 around 0.5 - 10 wt% with respect to the ion exchange material.

[0029] Furthermore, when the ion exchange materials are used in conjunction with activated carbon, and when the
10 ion exchange materials support heavy metals, the electrode chambers are filled with the ion exchange material which supports activated carbon or heavy metals along the surface of the electrode plates and this is effective in favoring reaction.

15 [0030] With the electric deionizer in Figure 1, production water (pure water) flows through the cathode chamber 18 which is filled with the ion conductive substance in this way, and therefore scale is prevented
20 from being generated in the cathode chamber 18, and so a reduction in the performance of the ion conductive substance caused by the scale is prevented.

25 [0031] Furthermore, the cathode chamber 18 outflow water which flows through the anode chamber 17 is pure water flowing into the anode chamber 17, and it does not contain an anion component, and moreover it contains reducing hydrogen which is generated in the electrode reaction inside the cathode chamber 18, and
30 therefore it is possible to prevent oxidative degradation of the ion conductive substance in the anode chamber 17.

35 [0032] Moreover, the electric deionizer shown in Figure 1 is one example of a mode of embodiment of the electric deionizer according to the present invention, but the present invention is not limited to the device shown in the figure, provided that any variations remain within the scope of the invention.

[0033] For example, with the electric deionizer shown in Figure 1, the enrichment chambers 15 are not filled with the ion conductive substance, but the enrichment 5 chambers may equally be filled with an ion exchange material or an ion conductive substance such as activated carbon or heavy metal. Furthermore, with the electric deionizer shown in Figure 1, production water serves as the cathode chamber 18 inflow water, but pure 10 water from a separate system or water from which the cation component has been removed by processing raw water in a cation exchange resin column (soft water) may equally be used as the cathode chamber 18 inflow water. Furthermore, instead of using the cathode 15 chamber 18 outflow water for the anode chamber 17 inflow water, it is feasible to use production water or pure water from a separate system or water from which the anion component has been removed by processing raw water in an anion exchange resin column. It is not 20 necessarily the case that some of the enriched water has to be circulated, and when the quality of the production water is more of a priority than the water recovery rate, raw water may be allowed to flow through for a time in any direction.

25

[0034]

[Effects of the Invention] As described above, the present invention provides an electric deionizer in which the electrical efficiency is improved by filling 30 the electrode chambers thereof with an ion conductive substance, and a reduction in the performance of the ion conductive substance which fills the electrode chambers of the electric deionizer can be prevented, thereby enabling long-term operation.

35

[Brief Description of the Figures]

[Figure 1] is a schematic view in cross section of an electric deionizer which represents a mode of embodiment of the present invention; and

[Figure 2] is a schematic view in cross section which represents a conventional electric deionizer.

[Key to Symbols]

- 5 11 anode
- 12 cathode
- 13 anion exchange membrane (A membrane)
- 14 cation exchange membrane (C membrane)
- 15 enrichment chamber
- 10 16 desalination chamber
- 17 anode chamber
- 18 cathode chamber

[Figure 1]

- 15 raw water
 - 11: anode
 - 12: cathode
 - 13: A membrane
 - 14: C membrane
 - 20 15: enrichment chamber
 - 16: desalination chamber
 - 17: anode chamber
 - 18: cathode chamber
 - waste water
 - 25 enriched water
- waste water
production water

[Figure 2]

- 30 raw water
- electrode water
- 13: A membrane
- 14: C membrane
- electrode water
- 35 11: anode
- 12: cathode
- 15: enrichment chamber
- 16: desalination chamber
- 17: anode chamber

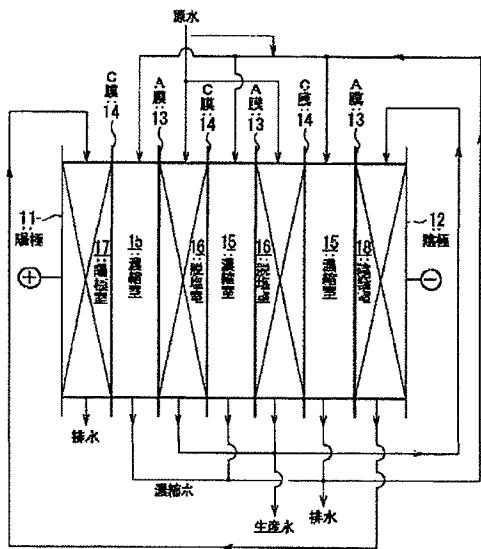
18: cathode chamber

enriched water

production water

waste water

【図1】



【図2】

